

California Division of Mines and Geology

Fault Evaluation Report FER-84

April 16, 1979

1. Name of fault

Part of the Elsinore fault.

2. Location of fault

Between Lake Henshaw and the southeastern end of the Coyote Mountains, San Diego and Imperial Counties (see figures 1 and 2).

3. Reason for evaluation

This area lies within the 1978 study area of the 10-year program for fault evaluation.

4. List of references

- Allison, M.L., Whitcomb, J.H., Cheatum, C.E., and McEuen, R.B., 1978, Elsinore fault seismicity: The September 13, 1973, Agua Caliente Springs, California, earthquake series: Bulletin of the Seismological Society of America, v. 68, n. 2, p. 429-440.
- Christensen, A.D., 1957, Part of the geology of the Coyote Mountain area, Imperial County, California. Unpublished MA thesis, University of California, Los Angeles, California.
- Clark, M.M., 1978, Map of the Elsinore and related faults, San Diego and Imperial Counties, California. Unpublished work in progress.
- Hart, M.W., 1964, Geology of an area including the Elsinore fault between Banner Grade and Vallecito Valley, San Diego County, California. Unpublished senior report, San Diego State College, San Diego, California.
- Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, California Geologic Data Map Series, Map No. 1, Scale 1:750,000.
- Langenkamp, David, and Combs, Jim, 1974, Microearthquake study of the Elsinore fault zone, southern California: Seismological Society of America Bulletin, v. 64, n. 1, p. 187-203.
- Merriam, R.H., 1958, Geology of Santa Ysabel quadrangle, San Diego County, California: California Division of Mines Bulletin 177, p. 7-21, 2 plates.

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Real, C.R., Parke, D.L., and Topozada, T.R., 1978, Magnetic tape catalog of California earthquakes, 1900-1974: California Division of Mines and Geology.

Scheliga, J.T., Jr., 1963, Geology and water resources of Warner Basin, San Diego County, California. Unpublished MA thesis, University of Southern California, Los Angeles, California, 82 p.

Todd, V.R., 1977, Geologic map of Agua Caliente Springs quadrangle, San Diego County, California: U.S. Geological Survey open-file report 77-742, 17 p.

Todd, V.R., 1978, Geologic map of Monument Peak quadrangle, San Diego County, California: U.S. Geological Survey open-file report 78-697, 39 p.

Weber, F.H., Jr., 1963, Geology and mineral resources of San Diego County, California: California Division of Mines and Geology County Report 3, 309 p.

#### Aerial photography

Designation: Fairchild C-5750

Date: 1939

Scale: 1:21,860

Type: black and white, vertical stereo

Coverage: Elsinore fault from Pauba Valley to Julian.

Availability: Fairchild aerial photography collection, Geology Department, Whittier College, Whittier, California.

Designation: Fairchild C-15152

Date: April 21, 1950

Scale: 1:26,000

Type: black and white, vertical stereo

Coverage: Elsinore fault, southeastward from Mason Valley to the Mexican border.

Availability: Fairchild aerial photo collection, Geology Department, Whittier College, Whittier, California.

Designation: Navy COP

Date: 1954

Scale: 1:37,333

Type: black and white, vertical stereo

Coverage: Elsinore and Earthquake Valley faults in the Julian, Earthquake Valley, and Monument Peak quadrangles.

Availability: San Francisco District office, California Division of Mines and Geology, San Francisco.

Designation: WRD-5D6

Date: June 28, 1967

Scale: 1:14,000

Type: black and white, vertical stereo

Coverage: Elsinore fault to the northwest of Mason Valley

Availability: Los Angeles District Office, California Division of Mines and Geology, Los Angeles.

5., 6., and 7. Summary of available data, interpretation of aerial photos, and field observations.

Knowledge of the existence of the Elsinore fault zone dates back at least to Fairbanks (1893), who described features of large-scale faulting in the Temecula-Elsinore area. The fault was first shown on a published map and mentioned by the name "Elsinore" by Lawson and others (1908, Map No. 1, and p. 19). Wood (1916) tabulated the historical earthquakes of California, and suggests that a number of the earthquakes may have occurred along the Elsinore fault. Davis (1927), discusses the characteristics of the major "rifts" of southern California; and, in several cases, refers to localities along the northern Elsinore fault as examples of various types of features.

A number of workers, including Christensen (1957), Merriam (1958), Scheliga (1963), Hart (1964), and Todd (1977 and 1978), have done mapping in this region that locally included part of the Elsinore fault zone. Most of these maps show the fault in a very generalized way. None of these maps is as detailed and specific in regard to features relating to recency as is the mapping of Clark (1978) and the writer. Figure 4 is a compilation of the mapping done by both Clark and the writer. The evaluation of the Elsinore fault, as discussed in this report, is based primarily on the work of Clark (1978) and the writer. Clark's mapping was done at various times in the early 1970's, and the writer's mapping was done during the first three months of 1979. Clark's mapping was accomplished by field reconnaissance (walking out the faults) using the Navy COP (1954) and the WRD-5D6 (1967) aerial photography.

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The writer, using all of the aerial photography listed under section 4 (references) of this report, made spot field checks along the fault at intervals of a few kilometers, and carried out detailed field mapping along some segments. On figure 4, Clark's mapping is shown in blue, or black lines highlighted in blue; the writer's mapping is black only.

The Elsinore fault, in the most general sense, is a right-lateral strike-slip fault. Geomorphic features exhibiting right-lateral offset comprise the most common form of offset evidence along most of the fault zone. On a somewhat more local scale, there is good evidence for offset in the vertical sense, but the uplifted block alternates from one side of the fault to the other over distances of a few tens of kilometers. Specifically, the southwestern side of the fault is upthrown along the Lake Henshaw and Carrizo Valley segments of the fault (segments are identified on figures 2 and 4), and the northeastern side is upthrown along the Santa Ysabel, Mason Valley, and Coyote Mountains segments. The dip of the fault plane varies from vertical to as shallow as  $45^{\circ}$  in either direction.

In the discussions that follow, the portion of the Elsinore fault that is considered in this report (approximately 90 km in length) is divided into nine segments. Each segment includes a portion of the Elsinore fault zone that exhibits a fair amount of consistency in terms of the recency of activity and general character of the fault.

In the discussion that follows, the Elsinore fault will be described in segments starting at the northwestern end (the Henshaw Dam segment). All references to map locations are to figure 4, unless otherwise stated.

#### Henshaw Dam Segment

This segment trends into the Mesa Grands quadrangle from the northwest (figure 4a). The trace splits into two traces, both of which pass beneath Henshaw Dam and extend to the southeast beneath Lake Henshaw. The

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more northeasterly of the two traces is characterized by obvious systematic right-offset of drainages. Several drainages are offset to distances ranging from 50m to 150m. Both traces are also characterized by eroded, northeast-facing scarps. Since the traces pass beneath a southwest-facing slope, the traces have a back-facing character. Both traces are well-exposed in roadcuts along the road about 250m west of Henshaw Dam. The northeastern trace shows a gouge zone about 10m thick, and the southwestern trace has about 2m of gouge. Both gouge zones occur entirely within granitic basement rock. The northeastern trace projects beneath what appears to be the deepest part of the earth-fill Henshaw Dam. The southwestern trace is again exposed near the base of the dam, and then projects to the southeast beneath a shallower part of the dam. I do not know what becomes of these traces to the southeast where they project beneath Lake Henshaw. It appears that the locus of recent movement steps to the right to the Lake Henshaw segment (figure 4a and 4b).

Clark (1978) mapped (shown in blue on figure 4a) only the more southeasterly of the two traces. I mapped the northeasterly trace on the basis of what I believe to be clear evidence, both topographic and in exposure. I also mapped another, older-appearing trace that lies about 250m farther to the southwest than the above-described southwestern trace. This trace is shown as a dashed line on figure 4a. It is characterized mainly by a vegetational contrast, but it also appears that it juxtaposes granitic basement rock on the northeast against older alluvium on the southwest. This last relationship is uncertain, however, because of poor exposure and a thick deposit of colluvium that has built up along the base of the mountain front in this area. I see no evidence for significant movement along this trace, either in Holocene time or in latest Pleistocene time.

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I could not find clear evidence, either in the photos or on the ground, for Holocene offset along the other two traces. However, the strongly developed, moderately youthful character of the fault-generated topography along both traces indicates that, if there has not been Holocene offset, then there has been substantial offset that occurred only very shortly before Holocene time.

#### Lake Henshaw Segment

This segment is characterized, along most of its length, by only one recognizable trace (figures 4a and 4b). This trace apparently forms a strong ground-water barrier to the northeasterly flow of ground water from the mountains to the southwest. The principal surface expression of the fault trace is abundant aligned springs and seeps. Vegetational lineaments are also common. Right-offset drainages and beheaded drainages are common only in a few places. Benches and low scarps also occur locally.

At the northwestern end of this segment, near the mouth of San Luis Rey Canyon, I mapped a one-kilometer long trace (dashed line on figure 4a) that has a rather weak surface expression. Although beheaded and right-offset drainages occur along this segment (see annotations on figure 4a), the offsets appear to have occurred before Holocene time; these features are well modified by erosion. There is no indication of Holocene activity along this short trace. Immediately to the southeast, in the vicinity of the Lake Henshaw recreation area, I was unable to map the fault across a dissected alluvial fan (sec. 10, T. 11 S., R. 2 E., figure 4a). The apparently unfaulted older alluvium of the fan may be older than Holocene age.

Farther to the southeast, the balance of the Lake Henshaw segment is accompanied by surface features whose general appearances suggest significant offset as recent as Holocene time. The numerous small beheaded drainages near

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the southeastern end of the segment (sec. 19, T. 11 S., R. 3 E., on figure 4b) are especially suggestive of Holocene offset. This last area is the only part of the Lake Henshaw segment that Clark (1978) mapped.

I observed no actual exposures of the fault plane along the Lake Henshaw segment.

#### Santa Ysabel Segment

The mapping of this segment (figures 4b and 4c) is entirely from Clark (1978). I have examined this area on photos (Fairchild C-5750, 1939) and, from that point of view, I generally concur with Clark's mapping. The surface features of the Elsinore fault along this segment are rather obscure and old in appearance. There are significant gaps where neither Clark or I could find any evidence for the location of the fault trace. Note the gap of several kilometers between the Lake Henshaw and Santa Ysabel segments. Although there are a number of right-offset, larger drainages along the Santa Ysabel segment, there is a noticeable lack of offset of the smaller drainages that cross the fault. The scarps that occur (mostly near the southeastern end of the segment) are well dissected and modified by erosion. Note the annotation "old" by Clark at one of the scarps shown near the northwestern corner of figure 4c. In general, the surface features along this segment do not suggest significant Holocene offset.

#### Banner Canyon Segment

The northwestern two-thirds of this segment was mapped by Clark (1978), and the southeastern third was mapped by both Clark and myself. To the northwest of the community of Banner (sec. 2, T. 13 S., R. 4 E., figure 4c) the fault traverses the lower part of the southwestern flank of Volcan Mountain. The surface features along the fault include benches, offset drainages, slope changes, and vegetation lineaments. The terrane through

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which this part of the fault passes appears to be composed entirely of crystalline basement rock. As such, nothing can be said as to whether late Pleistocene or Holocene units are cut by the fault. The topographic fault features are moderately youthful in appearance, but not so youthful as to demand the interpretation that significant Holocene offset has occurred. Nor do they preclude Holocene offset.

Near Banner, immediately to the southeast of Highway 78, there is a topographic feature that may be a modified scarp in older alluvium. It appears that the surface may have been offset vertically by the Elsinore fault, 1m to 2m, southwestern side upthrown. This apparent offset may, instead, have been generated by local stream erosion. In either case, it is probably of Holocene origin.

To the southeast of Banner, for a distance of about one kilometer, the fault zone is coincident with a very linear valley. Farther to the southeast, near the boundary between sections 11 and 12, T. 13 S., R. 4 E., the fault is characterized by a low, well-modified scarp that offsets an old, deeply weathered, gentle erosional surface. There are some seeps and springs along this scarp. The general appearance of the scarp indicates that it may have been formed as recently as Holocene time.

To the southeast of the above locality, the clarity of the topographic features related to the fault rapidly diminishes. In the upper part of Rodrigues Canyon, neither Clark or I were able to determine the location of the fault.

#### Mason Valley Segment

This segment begins, on the northwest, in Rodriguez Canyon and extends southeastward to the southeastern end of Mason Valley (figures 4c, 4d, and 4e). This segment is characterized by an apparently upthrown block along the northeastern side of the fault. The principal fault-generated

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surface features are benches, southwest-facing scarps, and right-offset drainages that occur along the base of the mountain front. These features increase in youthfulness of appearance toward the southeast along this segment. To the southeast of Box Canyon, youthful microtopographic features become common. These include narrow benches and scarplets, numerous areas of local ponding of alluvium, and sharp offset of small drainages. Near the northern edge of the Monument Peak quadrangle (figure 4e), Holocene alluvium at the mouth of a local canyon is clearly offset along several closely-spaced traces (too closely spaced to show in detail on figure 4e). Farther to the southeast, a low scarp extends across part of the extreme eastern end of Mason Valley. The valley-bottom surface that is offset by this trace is almost certainly of Holocene age.

#### Vallecito Valley Segment

This segment is represented by two sub-parallel northeast-facing scarps that extend across Vallecito Valley (figures 4e and 4f). The scarps are also accompanied by prominent vegetation lineaments and boundaries, suggesting that the scarps are the surface expression of significant faults; strong ground-water barriers would not otherwise have been likely to develop.

The scarps have been moderately dissected and modified by erosional processes. It is not clear how young the scarps are. The late Holocene and modern alluvium near the main watercourses is not offset. Somewhat older alluvium is offset. I have to assume that there is at least a reasonable probability that Holocene offset has occurred.

#### Carrizo Valley Segment

This segment is characterized by an apparently upthrown block along the southwestern side of the fault. The fault traces along this segment are

quite irregular in alignment and orientation. The fault appears to wrap around the ins and outs of the mountain front. This segment is different from the other segments in this respect. Also, along parts of this segment, there are many sub-parallel traces with surface features that vary considerably in their youthfulness of appearance. This suggests that the locus of movement has not been largely restricted to the same fault planes, but has migrated sideways from branch to branch with different earthquakes. Many of the traces shown on figure 4 are represented by surface features that have been so modified by erosion that it is doubtful they have had any Holocene offset. On the other hand, some of the most youthful features I have seen along the entire Elsinore fault system occur in this area. Near the boundary between sections 11 and 12, T. 15 S., R. 7 E. (figure 4g), what appears to be modern alluvium is offset about one meter vertically along a very fresh-appearing scarp. It appears that this surface rupture occurred within historical time, although there is no record of it. Toward the southeastern end of the Carrizo Valley segment, the fault traces have apparently been destroyed or buried by the outwash of some large drainages from the west. These include Indian Valley and Bow Willow Creeks (northwestern part of figure 4h).

#### Sweeney Pass Segment

This segment extends through the Sweeney Pass area, an area underlain by Pleistocene and possibly late Pliocene alluvial strata, and undergoing very rapid erosion. Because of the rapid erosion of the poorly consolidated alluvial strata, the fault-generated surface features are very rapidly destroyed. These features are preserved only within a few areas that are sheltered from erosion; the annotations on figure 4h indicate where these places are. The fault plane is, however, well-exposed near the eastern end

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of the segment where a number of fault-plane attitudes were obtained.

On figure 4h, there are two traces shown in the immediate vicinity of Sweeney Pass. The more southwesterly of these, shown as a trace about

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2km long on figure 4h, is not part of the through-going Elsinore fault, but is a branch fault that diverges from the Elsinore fault and continues to the southeast (unmapped). The northwesternmost kilometer of this shows youthful surface features, including benches and offset drainages, that are almost certainly of Holocene origin. To the southeast, however, there is a rapid decrease in the youthfulness of appearance of the fault-generated topographic features. I did not map this fault very far to the southeast of Sweeney Pass because of lack of time and because the aerial photography indicated that the fault has been very inactive in that direction. This fault apparently converges with the Elsinore fault to the northwest, beneath the floodplain of Carrizo Creek. This fault has apparently been active only at its northwestern end as it approaches the Elsinore fault.

The fault-generated surface features along the main trace of the Sweeney Pass segment are quite youthful in appearance, including much local micro-topography, and are clearly of Holocene origin.

Near the eastern end of the Sweeney Pass segment there are at least two traces that converge with the Elsinore fault from the northeast. These traces are well-exposed along the sides of Canyon sin Nombre, but there is no indication of Holocene offset. The faults have generated scarps across some remnants of an older alluvial surface to the northeast, but that surface is almost certainly of pre-Holocene age. I do not think these traces have been active during Holocene time.

#### Coyote Mountains segment

This segment is characterized by an upthrown block along the northeastern side of the fault. The segment consists of essentially one trace that extends along the base of the southwestern side of the Coyote Mountains

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(figures 4h and 4i). The trace is well-defined by an almost continuous series of scarps, benches, offset drainages, and offset ridge spurs. This segment was mapped by Clark (1978) but not by myself. I have examined the entire segment on aerial photos, and on the ground at several localities. In aerial photos, all of the segment except the northwestern and southeastern ends appears rather uniform with abundant, youthful-appearing fault topography. On the ground, in the area just west of Fossil Canyon (sec. 10 and 15, T. 16 S., R. 9 E., figure 4i), I observed very youthful micro-scarps that appear as though they could have been formed in historic time.

The fault features are rather obscure and difficult to follow along the northwesternmost one kilometer of the segment. I have no explanation for this. At the southeastern end of the segment, to the east of Fossil Canyon, I see no more evidence for Holocene faulting. The few traces that have been mapped, as shown on figure 4i, were field checked by myself, but I found no evidence for Holocene or latest Pleistocene offset. To the southeast of the Carrizo Mountain quadrangle (figure 4i), neither Clark or myself see any continuation of the Elsinore fault (at least, not within the United States).

#### Seismicity

The epicenter map, figure 3, shows the "A" quality epicentral data as compiled by Real and others (1978). Note that figure 3 is the same scale and covers approximately the same area as figure 2. The plots show a broad, regional relationship between the seismicity and the Elsinore fault zone. Clearly, however, there is more activity to the northeast of the fault than to the southwest. Note the cluster of events at the northwestern end of Lake Henshaw. This tends to support my interpretation, based on geomorphic

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evidence, that the Henshaw Dam segment is active for about the first two kilometers to the northwest of Henshaw Dam. There are several parts of the fault along which there is no recorded seismicity. But it must be borne in mind that the "A" quality epicentral data represent a very short time span of observation--mostly the past few decades. The epicentral distribution shown on figure 3 can hardly be expected to be representative of the Holocene seismic activity in this region.

## 8. Conclusions

I conclude that Holocene offset has definitely or probably occurred along all of the part of the Elsinore fault zone considered in this report except:

- (1) the southwesternmost of the three traces of the Henshaw Dam segment,
- (2) the northwesternmost one kilometer of the Lake Henshaw segment,
- (3) all of the Santa Ysabel segment,
- (4) parts of the branching traces along the Sweeney Pass segment, as discussed previously in this report, and,
- (5) traces within the southeasternmost 1.5km of the Coyote Mountains segment.

## 9. Recommendations

I recommend that special studies zones be established along all of the fault except for the exceptions stated above.

## 10. Investigating geologists name and date

*Drew P. Smith*  
Drew P. Smith  
April 16, 1979

*I agree with the zoning recommendations, except it would be prudent also to include those traces identified under (1) and (2) of the conclusions. Moreover, prudence dictates that the SE 6 km portion of the Santa Ysabel segment should be zoned because it aligns and is nearly contiguous with the Banner Canyon segment.*  
EWA  
4/23/79

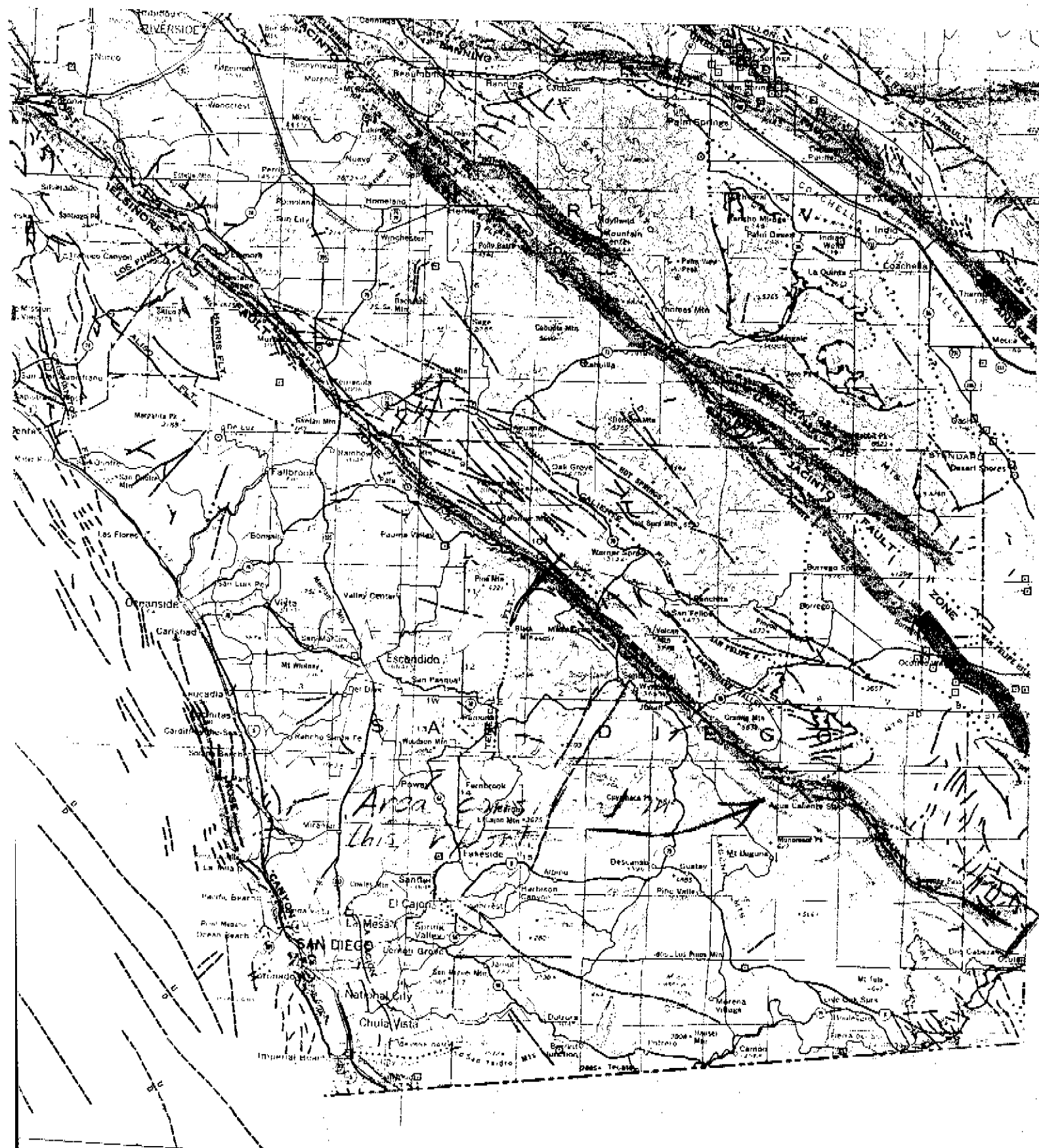


Figure 1. Index map showing the location of that part of the Elsinore fault zone that is considered in this report. Map is modified from Jennings (1975).

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